DESCRIPTION

«SYSTEM AND METHOD FOR CHECKING MECHANICAL PIECES, WITH
WIRELESS SIGNAL TRANSMISSION»

Technical Field

The present invention relates to a system for detecting the
position or dimensions of a piece, including at least a
checking probe with detection devices, a remote
transmission unit, connected to the detection devices of
the probe, and adapted for wirelessly transmitting pulse
signals indicative of the state of the probe, and a
receiver unit, adapted for wirelessly receiving signals and
including an input section, with at least one receiver
device, adapted for providing input signals, a generation
and control section adapted for generating and for defining
reference signals, and a comparison section connected to
the input section and to the generation and control
section, adapted for providing output signals responsive to
the results of comparisons between the input signals and
the reference signals, the generation and control section
including threshold generating circuits and automatic
checking circuits for automatically checking the difference
in amplitude between the input signals and the reference
signals.
The invention also relates to a method for checking the
dimensions or the position of a piece, by means of at least
one checking probe including detection devices, at least
one remote transmission unit connected to the checking
probe and adapted for wirelessly transmitting signals in
the form of pulses, and a receiver unit, adapted for
receiving the signals in the form of pulses, whereby input
signals in the receiver unit are compared in amplitude with
reference signals for providing output signals, and the
difference in amplitude between the reference signals and
the input signals is varied in a dynamic way.

Background Art

There are known measuring and control systems, e.g. in
5   numerical control machine tools, for detecting the position
and/or the dimensions of machined pieces by a contact
detecting probe, mounted in the machine. In a system of
this type, shown in simplified form in figure 1, a checking
probe **1**, for example a contact detecting probe, that, in
10   the course of a checking cycle, displaces with respect to a
piece **3** being machined, touches the surfaces to be checked
and responds to contact, detected by suitable detecting
devices identified with reference number **2**, by wirelessly
transmitting, by means of a transmitter **4**, pulse signals **5**
15   – that identify the state of the probe **1** – to a receiver **7**,
usually located at a certain distance from the probe **1**. The
receiver **7** is in turn connected, by means of an interface
device **9**, to the numerical control unit **11** of the machine
that, by processing other signals indicative of the spatial
20   position of probe **1**, obtains information about the position
of the surfaces of the piece **3**. At times the interface
device **9** can be integrated at the interior of the receiver
7.
The contact detecting probe can include electric batteries
25   for the power supply of contact detecting circuits and of
the transmitter **4** that can operate, for example, by
emitting signals (**5**) of optical or radio-frequency type.
U.S. patent No. US-A-5778550 discloses a measuring system
with these characteristics and describes a checking probe
30   with circuits for sending suitably coded, optical signals
in the infrared band, and a receiver unit including one or
more photodiodes, amplification circuits and shaping
circuits for reconstructing a sequence of pulses
corresponding to the received optical signals. In the
35   shaping circuits, the received and amplified signal is
compared with a suitable threshold, whose value can be
altered for varying the sensitivity of the receiver in the

course of specific operation phases of the system.

There are also known systems with receiver units **7** that include the characteristics described in the prior art portion of claim 1, as shown in simplified form in figure 2, where an input section includes a receiver device, for example a photodiode **13**, that receives the optical signals **5** and amplification circuits with an amplifier for example of the differential type, **15**, whose output, more particularly the amplitude of the amplified signal, or input signal, is compared, in the circuits of a comparison section **20**, with values of a reference signal, or threshold, for generating – and sending to the interface device **9** – a sequence of pulses including the information received from the remote probe **1**. Typically, the optical signals **5** are transmitted by the probe **1** as groups or trains of coded pulses, for example groups of few pulses of few microseconds. The groups occur at approximately 15-20 millisecond intervals.

The threshold is generated and dynamically varied by the circuits of a generation and control section **16**, on the basis of both indications arriving from a logic **17** and attributes of the received optical signal **5**.

More specifically, the logic **17** communicates to generating circuits **30** of the section **16** information relating to the specific application, for example on the basis of data that the operator has set in hardware (dip-switch) memories, and/or to particular operation phases, as briefly cited above with reference to patent No. US-A-5778550. Dynamic variations of the threshold are instead caused by automatic control circuits, more specifically detecting circuits **40**, on the basis of amplitude peaks of the input signals. In practice, the threshold is quickly varied, with respect to a maximum sensitivity value defined on the basis of the signals of the logic **17**, so as to reduce its distance from the peak amplitude of the input signal, and to maintain a reduced sensitivity for a short period of time, sufficient for preventing the generation of false output pulses owing

to possible signal distortions in the receiver circuits
when the signal is strong.

A typical case foresees, for example, quick threshold
increments (or decrements, if the threshold has negative
5   value) until reaching values close to the peak amplitude of
the input signal, with time constant in the order of the
microsecond, and a return to the maximum sensitivity value
within a period of time in the order of the millisecond.
The time interval in the course of which the sensitivity of
10 the receiver is diminished is sufficiently long for
overcoming noises that could occur caused by the distortion
of a group of pulses.

Probe receivers with these characteristics are manufactured
and marketed with good results by the same applicant of the
15 present patent application since the 90's. These receivers
include, among other things, circuital components acting as
high-pass filter for reducing the negative effects due to
the continuous and low-frequency components of the
surrounding environmental illumination and for inhibiting
20 from subsequent processings low-frequency noise components
emitted, for example, by fluorescent and incandescent lamps
located in the surrounding environment where the receiver
operates. The winding or inductor **14** of figure 2 shows, in
simplified form, the previous high-pass filter.
25 Furthermore, there can be foreseen cells for the high-pass
filtering at the interior of the amplifier **15**.

However, there is the possibility that radiations emitted
in an unforeseeable way by fluorescent lamps or by other
sources of light in the environment be processed by the
30 receiver together with the signals transmitted by the probe
thereby causing malfunctions.

It has been experienced that fluorescent lamps emit
improper and unforeseeable radiations, even in the infrared
radiation band, and that these radiations have considerable
35 high-frequency amplitude modulation components, i.e. in the
frequency band of the useful signals, in other terms of the
pulse signals **5**. These radiations vary depending on the

- 5 -

type of lamp, on the environment temperature, on the power
supply voltage, on the age and the efficiency conditions of
the lamp itself.

In the known embodiment shown in figure 2 the maximum
5   sensitivity is reset after the elapse of a time that is
relatively short with respect, for example, to the typical
time interval between groups of pulses transmitted by the
transmitter **4** of the probe **1**. It is possible to envisage to
lengthen this time for improving immunity to noise, but
10   this could involve the risk of loosing "good" signals, if
the amplitude of these signals rapidly decreases in
consequence, for example, of the probe **1** rapidly displacing
away from the receiver **7**.

15   Disclosure of the Invention

Object of the present invention is to provide a system and
a method for checking the position and/or the dimensions of
mechanical pieces that, by preserving the positive accuracy
20   and the intrinsic reliability characteristics of the known
systems and of their associated methods that utilize a
probe with wirelessly detecting and transmitting devices,
are extremely reliable even when there are electromagnetic
noises in the surrounding environment.
25   This and other objects are achieved by a system in which
the automatic checking circuits include discriminating
circuits adapted for detecting at least one attribute of
the input signals and for varying the difference in
amplitude if the detected attribute corresponds to
30   wirelessly received signals that differ from the pulse
signals transmitted by the remote unit.
This object is achieved also by a method including the
steps of identifying the noise signals on the basis of
attributes differing from those of the signals transmitted
35   by the remote transmission unit, and consequently varying
in a dynamic way the difference in amplitude.
According to a specific embodiment, the attribute of the

- 6 -

received signals that is checked and identified is the distribution, as a function of time, of the amplitude of the signal.

Systems and methods according to the present invention, by relying the sensitivity variations of the receiver on the identification and on the discrimination of the unwanted signals as compared to the useful signals, concurrently guarantee immunity to environment noises and reliability insofar as the proper reception of the useful signals arriving from the probe transmitter are concerned.

Brief Description of the Drawings

A preferred embodiment of the invention is hereinafter described with reference to the enclosed sheets of drawings, given by way of non-limiting example, wherein:

figure 1 shows, in simplified form, a machine tool carrying a checking probe for detecting the position or linear dimensions of mechanical pieces;

figure 2 is a partial functional block diagram of a unit for receiving coded radiations according to a known embodiment;

figure 3 is a partial functional block diagram of a unit for receiving coded radiations according to an embodiment of the invention;

figure 4 is a partial functional block diagram of the receiver unit of figure 3, with greater functional details;

figures 5, 6 and 7 are graphs showing the trends of some of the signals in the receiver unit of figure 4; and

figure 8 is a diagram showing some functional blocks of a receiver unit according to an embodiment alternative to the one of figure 4.

Best Mode for Carrying Out the Invention

The previously partially described figure 1 illustrates, in simplified form, a system for checking the position and/or

the dimensions of the piece **3** on the machine tool (for example a machining center identified in the figure by reference number **6**), where the piece **3** is machined. The computer numerical control **11** supervises the operation of

5   machine tool **6**. The checking probe **1** is coupled to slides and carries a remote transmission unit (the previously mentioned transmitter **4**) for transmitting infrared optical signals to the receiver, or receiver unit **7**, that, for example, is coupled with the bed of the machine tool **6**.

10   Some components of the receiver unit **7** are shown in simplified form in figure 3 in which like reference numbers as those of figure 2 are used to denote like parts. In substance, the receiver unit **7** shown in figure 3 differs from the receiver shown in figure 2 insofar as section **16'**

15   is concerned, where, with respect to section **16**, the automatic checking circuits also include discriminating circuits **50** that, like the detecting circuits **40**, receive the input signals and an output of the threshold generating circuits **30**, and have the output connected to the latters.

20   As hereinafter described in more detail, in the receiver unit **7** the circuits of the generation and control section **16'** enable to dynamically generate and define the threshold not just based on the amplitude peak of the received and processed signal (per se known detecting circuits **40**), but

25   also by singling out (discriminating circuits **50**) an attribute of the input signals that identifies it as a noise signal emitted, for example, by a fluorescent lamp located in the surrounding workshop environment. This attribute can be, according to a preferred embodiment of

30   the present invention, the distribution of the amplitude as a function of time or, according to one of the possible alternatives hereinafter not described in detail, the distribution as a function of frequency (spectral characteristics of the signal).

35   While the transmitter signals consist, as previously described, in trains of few pulses (typically 3 or 4), each of few microseconds (for example 4µs), and these trains

occur every 15-20 milliseconds, it has been realized that
the noises emitted by fluorescent lamps are distributed in
an unforeseeable way but always have greater "density" with
respect to the useful/useable signals. In other terms, the
5   duty-cycle of the noises, i.e. the ratio between the time
in the course of which - at a specific interval - the
amplitude of the noise takes non-negligible values and the
duration of said interval, is definitely longer than that
of the useful signal.
10 Figure 4 shows in more detail with respect to figure 3 a
partial functional diagram of the receiver unit 7 according
to the invention.
More particularly, in the comparison section 20 there is an
analog inverter 21, connected to the output of the
15 amplifier 15, and two comparators 23 and 24 that compare,
respectively, the output of the amplifier 15 and of the
inverter 21, with the threshold generated by circuits 30.
The outputs of the comparators 23 and 24 are utilized for
setting and for resetting a bistable multivibrator or flip-
20 flop, represented by the "NAND" logic gates 26 and 27
suitably interconnected, the output of which is sent to the
interface device 9.
In the threshold generator circuits 30, a fixed current
generator 32 and a variable current generator 33 are
25 represented, the latter being connected to the logic 17 and
to the output of the discriminating circuits 50. Other
component parts of the generating circuits 30 are two
resistors 35 and 36 and a capacitor 38.
In the detecting circuits 40 there is a voltage generator
30 41, connected to the output of the amplifier 15, and a
differential amplifier 43 that receives at the input both
the signal arriving from the amplifier 15 increased (in
algebraic terms) by the signal of the generator 41, and an
output of the generating circuits 30. The output of the
35 differential amplifier 43 is also connected to the
generating circuits 30 through circuital components
represented by a resistor 45 and a diode 47.

Lastly, the discriminating circuits **50** include an additional comparator **51**, a low-pass filter **53** of the first order with relatively high time constant (in the order of a tenth of a second), an additional differential amplifier

5   **55**, a voltage generator **57** and a diode **59**. More specifically, the additional comparator **51** receives, from the amplifier **15**, the input signals and also a dedicated output of the generating circuits **30**, and provides the low-pass filter **53** with a signal that reaches the additional

10   differential amplifier **55**. The latter, that also receives the voltage supplied by generator **57**, has the output connected, through the diode **59** (that normally does not conduct), to a dedicated input of the generating circuits **30**, in particular to the variable current generator **33**.

15   The operation of the receiver unit **7** shown in figure 4 will now be described with the aid of the graphs of figures 5, 6 and 7.

The first graph line of figure 5 represents the signal **5**, in form of optical pulses, transmitted by the transmitter **4**

20   and received by photodiode **13**. As previously described, the signal **5** typically includes trains of few microsecond pulses at several millisecond time intervals. For the purpose of providing simplicity to the description, the signal **5** represented in figure 5 does not comply with the

25   proportion between the duration of the trains of pulses (microseconds) and the time interval between two subsequent trains (milliseconds). In consequence, the above applies analogously to the other graphs of figure 5 and figures 6 and 7.

30   The photodiode **13** is inversely polarized by a suitable polarization voltage **VP** and the current flowing in it, that is proportional to the incident optical power, flows across the inductor **14**, at the terminals of which there is therefore available a voltage that approximate the

35   derivative of the incident optical signal **5**. The derivation made by the inductor **14** strongly attenuates the continuous and low-frequency components due to environment light.

- 10 -

Another advantage provided by the use of the inductor **14** as load of the photodiode **13** is that the inverse polarization of the photodiode **13**, necessary for its correct operation, is maintained even if the latter allows a relatively strong
5   direct current to flow owing to intense environment illumination. In practical embodiments, the inductive impedance of the inductor **14** can be synthesized, in a per se known way, by suitable circuits with active components so avoiding the use of windings that have known negative
10 drawbacks, as layout dimensions, fragility, parasitic capacity, etc. Then the signal is amplified by the amplifier **15**.

According to a preferred embodiment, the transfer characteristic of the amplifier **15** is not linear, so when
15 strong signals are received their amplitude is compressed, by means of a per se known controlled distortion, in order to prevent the saturation of amplifier **15**. Furthermore, the amplifier **15** implements, in an also known and herein not minutely described way, an additional high-pass filter
20 against the low-frequency noises of the environment light. The input signal **VA** provided by the amplifier **15** consists of short pulses with negative and positive polarity, respectively at upward and downward fronts of the received optical pulses **5**. The amplifier **15** introduces, because of
25 the poles associated with its high-pass transfer function, small transitory components ("tails") at the end of each pulse. These components become evident when the received signal is very strong, but they do not create inconveniences thanks to the operation of circuits **30** and
30 **40**, as previously mentioned, and thus, for the sake of greater clarity, have not been shown in the drawings. The signals **VA** and **VINV**, the latter obtained by polarity inverting the signal **VA** by means of the analog inverter **21**, are provided to the comparators **23** and **24** that compare said
35 signals with a reference signal, more specifically a threshold voltage **VTH** supplied by the generating circuits **30**. By assuming that the diode **47** does not conduct (this

occurs, for example, when it does not receive any type of signal), the threshold voltage **VTH** has, for example, basis value **VTH0** negative and proportional to currents **I0** (fixed) and **I1** (variable) supplied by the generators **32** and **33**, respectively. The fixed current **I0** defines the maximum sensitivity threshold. In order to guarantee good performance, it is obviously desirable that the value of the maximum sensitivity threshold be, in terms of absolute value, as small as possible. However, its absolute value must also exceed, with adequate margin, the peak value of the electric noise intrinsically generated by the amplifier **15** and by the photodiode **13**. The generator of the variable current **I1** is controlled by the logic **17** and also by the discriminating circuits **50** – as hereinafter described – and its function is to further shift the basis value **VTH0** of the threshold voltage **VTH** in order to reduce the optical sensitivity. In the described example this shift is towards more negative values of the amplitude of **VTH**. The reduction can be set by the operator, by operating manually-operated programming devices or dip-switch **18** (figure 4), in order to attempt to solve problems of optical noise reception, or it can be carried out when specific control functions, as those described in the previously mentioned patent No. US-A-5778550, are enabled, again upon the operator's request. In any case, in the known system of figure 2, the current **I1** does not dynamically vary as a function of the received signals.

When the peak amplitude of the signal **VA** exceeds in terms of absolute value the voltage **VTH** by a predetermined minimum amount, defined by the voltage generator **41**, the diode **47** conducts and thus a feedback loop closes, causing the threshold voltage **VTH** to vary towards values that are the more negative the more the received optical signal **5** is strong, hence providing a reduction in sensitivity. The values of resistances **R1**, **R2** and **R3** of resistors **35**, **36** and **45** and of capacity **C1** of capacitor **38** define the amounts of time required for the threshold voltage **VTH** to change and

for the voltage to return to the basis value **VTH0** previously set and defined by the currents **I0** and **I1** and by the resistances **R1** and **R2**. More specifically, the resistance **R3** of the resistor **45** has considerably smaller value than the resistances **R1**, **R2** of the resistors **35**, **36**. Therefore, the time constant for the actuation (decrease of the voltage **VTH**) defined by **R3*C1** is very short (approximately 1µs), for allowing the level of **VTH** to be shifted even by a single pulse of the signal **VA**. On the contrary, the time constant for returning to the basis value **VTH0**, defined by **(R1+R2)*C1** is definitely longer (in the order of magnitude of 1ms), higher than the duration in time of the train of pulses of the useful signal **5**.

Hence, at the output of the comparators **23** and **24** there are short pulses, represented in figure 5 with the lines **VS** and **VR**, respectively, at the upward and downward fronts of the received optical pulses **5**. Therefore, the flip-flop consisting of "NAND" gates **26** and **27** is alternatively set and reset so as to reconstruct a sequence of pulses (output signal **VO**) corresponding to the sequence of the pulse signal **5** transmitted from the transmitter **4** and received by the photodiode **13**. The signal **VO** is sent to the interface device **9**, that can be integrated in the receiver **7**, where subsequent known processings enable to trace back to the information arriving from the probe **1**.

In the discriminating circuits **50**, the input signal **VA** provided by amplifier **15** is compared with a fraction of the threshold voltage **VTH** defined by the ratio of the values of the resistances **R1** and **R2** of resistors **35** and **36** (if **R1=R2** the threshold at the input of comparator **51** has halved value with respect to the threshold **VTH**). When the receiver unit **7** receives the signal **5** with no substantial noises, according to the arrangement herein so far described with reference to figure 5, the outcome of the verification carried out in the discriminating circuits **50** is negative and no control signal is sent to the variable current generator **33** through the associated dedicated connection.

- 13 -

In fact, the threshold of comparator **51** is exceeded only by very short time intervals (pulse signal **VI**), at the upward fronts of the optical pulses **5**, and the output signal **VD** of the low-pass filter **53** is held below the fixed comparison
5   value **VX** defined by the voltage generator **57**, so keeping diode **59** in a non-conducting state. The voltage generator **57** is suitably dimensioned and the exceeding of the comparison value **VX** indicates the presence of a signal, arriving from the amplifier **15**, with definitely higher
10   duty-cycle than that of the sequence of optical pulses **5**.
      In practice, in the arrangement shown in figure 5 the discriminating circuits **50** do not intervene and the so far provided description corresponds to the known prior art mentioned with reference to figure 2. The temporary
15   reduction in sensitivity controlled by the detection circuits **40** prevents the generation of spurious pulses caused by possible distortions of the received signal **5** but, as already mentioned, does not provide adequate protection against sufficiently strong noises arriving, for
20   example, from fluorescent lamps.
      In figure 6 the first line represents a noise signal **NS** emitted, for example, by a fluorescent lamp and received by the photodiode **13**.
      The presence of the noise signal **NS** is detected in the
25   discriminating circuits **50** where the output signal **VI** output of the additional comparator **51** appears qualitatively different with respect to the arrangement of figure 5. In practice there is revealed the presence of a signal with sufficiently high duty-cycle that enables the
30   low-pass filter **53** to generate a slowly variable (owing to the characteristics of the filter **53**) signal **VD** that exceeds the fixed comparison value **VX** defined by the voltage generator **57**. The output of the additional differential amplifier **55** causes the diode **59** to conduct
35   and determines an increase in the current **I1** supplied by the variable current generator **33** with a consequent decrease (an increase in absolute value) of the basis value

VTH0 of the threshold VTH. In practice, the threshold VTH
takes slowly variable values, that follow the trend of the
output signal VD of the low-pass filter 53, that, in terms
of absolute value, are greater than the peak value of the
5   noise signal NS. More specifically, the diode 59 closes a
further feedback loop that, if the loop gain is
sufficiently high, causes VTH to be more negative so that
the fraction of its absolute value, defined by the ratio of
the values of the resistances R1 and R2 of the resistors 35
10   and 36 and sent to the non-inverting input of the
comparator 51, approaches the peak value of VA. In
consequence, the absolute value of VTH0 exceeds the peak
value of VA: if R1 = R2, it approaches the double of the
peak value of VA.
15   As a consequence of the rise of the basis value VTH0 of the
threshold VTH, the comparators 23 and 24 do not generate
any pulse (lines VS and VR), and there is no signal (VO) at
the output of the flip-flop consisting of the "NAND" gates
26 and 27. Thus the receiver is properly unaffected by the
20   noise NS. Under these conditions the signal VA provided by
the amplifier 15 does not reach (and therefore neither does
it exceed) the value VTH0 of the threshold VTH and thus the
diode 47 does not conduct, and the detecting circuits 40 do
not cause any variations in the threshold VTH.
25   The graphs of figure 7 show the arrangement according to
which the photodiode 13 receives a signal 5+NS, i.e. a
noise NS superimposed on a useful signal 5. The first line
in figure 7 indicates the signal 5+NS.
In this case, both the detecting circuits 40 and the
30   discriminating circuits 50 dynamically vary the threshold
VTH that undergoes, owing to the effect of the formers
(40), quick increments at the upward fronts of the received
signal 5, and owing to the latters (50) returns to values -
proportional to the fixed current I0 and variable current
35   I1 - that exceed in terms of absolute value the peak value
of the noise NS, but, thanks to the relatively high time
constant of filter the 53, can be exceeded by the amplitude

of the short optical pulses **5** arriving from the transmitter **4**, obviously under the hypothesis that the latters are received with intensity that is sufficiently greater than that of the noise **NS**. In the event that, at the pulses of the useful signal **5**, the signal **VA** surpasse by little, in terms of absolute value, the threshold **VTH**, the detection circuits **40** would not intervene. Thus even when there are noises **NS**, the proper reconstruction of the sequence of pulses **VO** as described with reference to figure 5 is enabled whereas, thanks to the discriminating circuits **50**, the sensitivity of the receiver **7** is suitably and dynamically diminished to obtain immunity to the noise signals **NS**. In figure 7 it is possible to easily distinguish the two different decay time constants of the threshold **VTH**: the shorter time constant is due to the detecting circuits **40**, while the longer one is due to the discriminating circuits **50**.

In practice, the parameters of the discriminating circuits **50** are chosen so that when just the useful signal **5**, that has a very short duty-cycle (approximately one per thousand), as previously described, is received, the voltage **VD** output from filter **53** does not reach the fixed reference value **VX**. In this way the sensitivity of the receiver **7** is not diminished at all. On the contrary, if just noise **(NS)** is received, the threshold **VTH** is suitably shifted and in this way, by diminishing the sensitivity of the receiver **7**, it is possible to prevent the sending of noises to the interface device **9**. If, in the second case, a useful signal **5** with sufficient amplitude overlaps the noise **NS**, the former is properly reconstructed **(VO)** and noiseless transmitted to the interface device **9**.

In fact, it is true that the addition of the useful signal **5** initially increases the number of pulses of the sequence **VI** at the output of the additional comparator **51**, and consequently tends to increase **VD** and thus further decrease (increase, in terms of absolute value) **VTH**. Nevertheless, just a very small decrease of **VTH** is sufficient for

- 16 -

strongly reducing the contribution of the noise **NS** to the generation of pulses **VI** by the additional comparator **51** and prevent a further diminution in sensitivity. Therefore, in this case too, the useful signal **5** practically has no
5   effect on the basis value **VTH0** of the threshold **VTH** as defined by the currents **I0** and **I1** and the varying of the basis value **VTH0** of the threshold **VTH** in practice only depends on the received noise **NS** and is of greater amplitude with respect to the peak value of the noise **NS**.
10   According to a practical embodiment of the receiver unit **7**, shown in simplified form in figure 4, a transistor NPN configured as common emitter amplifier with a resistance in series with the emitter can accomplish in a per se known way the functions of the additional differential amplifier
15   **55**, of the voltage generator **57**, of the diode **59** and of the variable current generator **33**. In this practical embodiment, the fixed comparison value **VX** is thus approximately 0,65 V and the value of the current entering the collector is approximated by the ratio between the
20   basis potential diminished by 0,65 V and the resistance of emitter.
       According to a possible alternative to the herein so far described embodiment of the receiver unit **7**, the output of the discriminating circuits **50** is not connected to the
25   generating circuits **30** for varying the threshold **VTH**, but to the amplifier **15** for suitably controlling its gain. In figures 3 and 4 a broken line **60** indicates the functional connection to the amplifier **15** of the discriminating circuits **50**, more specifically of the diode **59**. This
30   alternative embodiment enables to obtain a reduction in sensitivity of the receiver **7** when there are noise signals **NS** in an entirely equivalent manner as that described with reference to figures 6 and 7.
       In practice, depending on the output of the discriminating
35   circuits **50**, the difference in amplitude between the signal **VA** provided by the amplifier **15** and the threshold voltage **VTH** is in any case dynamically varied. In the embodiment

described above with reference to the figures, it is the threshold **VTH** that is varied, more specifically increased (in terms of absolute value) for diminishing the sensitivity. In the alternative embodiment, schematically

5   shown by line **60**, the sensitivity of the receiver **7** is diminished by symmetrically attenuating the amplitude of the input amplified signal. From the circuitral point of view, the amplitude of the signal **VA** can be controlled in a known way, for example, by means of a field effect

10 transistor, whose channel resistance is varied by the gate voltage, or by a structure with bipolar transistors, whose transconductance is varied by the control signal arriving from the discriminating circuits **50**.

Some functional blocks of a possible alternative

15 configuration of the receiver unit of figure 4 are shown in figure 8, and include a transconductance amplifier **15'** (being a particular embodiment of the amplifier **15**), a further fixed current generator **72** and a further variable current generator **73**. The amplifier **15'** has a

20 transconductance **gm** (i.e. a ratio of output current variation to the input voltage variation) that is controlled by currents I_{A0} (fixed) and I_{AV} (variable) provided by the generators **72** and **73**. The currents I_{A0} defines the maximum gain of the amplifier **15'**. The variable

25 current generator **73** is coupled to the output of the diode **59** through coupling **60**, in order to control the variable current I_{AV}.

Figure 8 shows just a possible embodiment of an amplifier whose gain can be controlled on the basis of a variable

30 entity, other known solutions being possible.

Other possible circuital and/or functional arrangements, that enable to dynamically vary the difference between the signals **VA** and **VTH** based on the attributes of the received signal detected by the discriminating circuits **50**, fall

35 within the scope of the present invention.

Thus, the receiver unit **7** of a system according to the present invention enables to check in an automatic way the

sensitivity of the receiver **7** by verifying attributes of the received signal, the consequent identification of noise signals **(NS)** and the variation of the threshold or, in general, of the difference between the input signal **(VA)** and the threshold **(VTH)**, in a way that the latter is sufficiently above the peak value of the component of the signal **VA** due to the noises **NS**. In this way the system is immune to noises caused by unexpected and unwanted signals (in the described arrangement, optical signals) in the workshop environment, while continuing to guarantee the proper reception of the useful signals **(5)** even in the case of a quick drop of intensity of the latters, caused, for example, by the probe **1** and the associated transmitter **4** rapidly displacing away from the receiver **7**.

Obviously it is necessary that when there are noises, the useful signal **(5)** be received with adequately greater intensity than that of the noises **(NS)**, as typically required for the correct operation of telecommunication systems.

Hence, in a system and a method according to the present invention it is possible to automatically adapt the sensitivity of the receiver **7** to the specific noise situation (more specifically, optical noises) in the surrounding environment, and thus exploit in an optimum way the signal-noise ratio.

Systems and methods according to the invention can differ in terms of implementation with respect to what has been herein illustrated and so far described.

In the automatic checking circuits of the receiver unit **7** it is possible to leave out, or disable, for example, the detecting circuits **40** that have the function, as noted above, of rapidly and temporarily varying the amplitude difference between the input signal **VA** and the threshold voltage **VTH** for providing immunity to the receiver **7** not against external noises, but against unwanted pulses generated by the arrival of the actual useful signal **5**, particularly if the latter has great intensity.

It is also possible to leave out the derivation made by the inductor **14** and, in consequence, give up the already previously mentioned benefits it provides. In this case the aspect of the signal **VA** will be the more alike the received

5   optical pulses **5** and thus it can be reconstructed by simply comparing it with the threshold **VTH** by means of a single comparator, therefore sparing the other comparator, the inverter **21** and the flip-flop **26, 27**.

According to another possible embodiment of the receiver

10   unit **7**, the presence of the amplifier **15** is not foreseen. For example, when the photodiode **13**, acting as a current generator, is "loaded" with a suitably high impedance **14** in the frequency band of the useful signals, the input signal **VA**, supplied by the photodiode **13**, has sufficiently high

15   amplitude and does not need further amplification.

Obviously, even if in the arrangement of figure 4 the threshold **VTH** has negative value (as the pulses of the signals **VA** and **VINV** are negative, owing to the particular interconnections of the various components and circuits,

20   corresponding, respectively, to the upward and downward fronts of the received optical pulses **5**), it is possible to invert the polarities of the signals **VA** and **VINV** in output from the amplifier **15** and from the inverter **21** (in this specific case is the same as exchanging them) and the sign

25   of the threshold **VTH** without affecting in any way the essence of the invention.

Furthermore it is possible to implement the invention by utilizing systems in which the transmitted signal **5** is of a different type, for example a radio-frequency pulse signal

30   instead of an optical signal.

A system according to the present invention can obviously include a plurality of probes **(1)** with associated transmitters **(4)** that transmit signals to one (or more) receiver units **(7)** that can, in turn, include a plurality

35   of photodiodes or other receiver devices **(13)**.

In a system as the herein described one, there can be foreseen the possibility of enabling or not the automatic

sensitivity check of the receiver **7** implemented by means of
the discriminating circuits **50**, in order to carry out
verifications and tests in the event anomalous behaviour
occur (for example, in the event it is desired to verify
5   the actual presence of noise signals **NS** in the
environment).

This can be performed in a manual way, by means of the
manually-operated programming devices **18**, or by means of an
additional conductor in the interface connection cable (not
10 shown in the figures), dedicated in a known way to the
managing of the options about the sensitivity of the
receiver **7**. Therefore, there are many ways for implementing
and controlling the sensitivity check, by means of
different types of connection of the additional conductor.
15 Just as an example, if the conductor is disconnected, it
can correspond to a condition according to which the
automatic sensitivity check is disabled and the sensitivity
of the receiver **7** is the nominal one (current generator **33**
off), if the conductor is connected to ground, the optical
20 sensitivity is reduced, for example, in a permanent way
with no automatic variations, whereas if the conductor is
connected to a positive power supply voltage, it is
possible to enable the automatic sensitivity check.